the variation. It was entirely confined to the retina. Further, the phenomenon is in no way restricted to one or two observers. If this were so I would not enter so fully into the matter. Instead of being restricted, I believe it to be a condition of vision.

I have already referred to well-known observers, Barnard, Pickering, and Chandler, who have abundantly testified to its existence, as far as they were concerned. Recently Dr. W. J. S. Lockyer, in his valuable dissertation on the period of η *Aquilæ*, finds that Schmidt's observations are affected by a systematic error depending on the relative position of the variable and its comparison stars.

Indeed, there are few observers who have made the visual determination of star magnitudes a particular line of research who have not been brought face to face with the difficulty.

Lovedale: 1899 *May.*

Note on the Construction and Use of Réseaux.

By Arthur R. Hinks, M.A.

Very little has been published on the construction and use of *réseaux* since Professor Vogel described in the *Bulletin du Comité Permanent*, vol. i. p. 86, the experiments undertaken by Dr. Scheiner, when, at the inauguration of the Astrographic Chart, the study of the subject was confided to the Potsdam Observatory. A few scattered references show that astronomers engaged on the chart work have generally followed Dr. Scheiner in endeavouring to secure extreme fineness of the photographed image of the *réseau* by the use of very finely ruled *réseaux* placed very nearly in contact with the plate.

Some experiments which I made last year suggest that this procedure may with advantage be modified.

In the first place, it seems doubtful if one should aim at making the image of the *réseau* line as fine as a micrometer wire, unless Professor Turner's form of micrometer is used, in which the point of intersection of the line with a glass scale has to be *estimated*. It is certainly easier to set a wire upon a line well defined, but broader than itself.

Secondly, it is inconvenient to be obliged to place the plate very close behind the *réseau*. The use of commercial plates at any time is then quite out of the question, since they frequently deviate from flatness by several tenths of a millimetre. And even patent plate-glass plates occasionally have sufficient curvature to bring them into contact with and cause damage to the *réseau*.

The lines in the Gautier *réseau*, No. 86, belonging to the Cambridge Observatory, are about $0^{mm}\cdot01$ wide. A plate was placed behind this in a tilted position, so that one end was in contact with the *réseau* and the other end separated from it by a measured amount. The definition of the image fell off very rapidly, and with a separation greater than $0^{mm}\cdot05$ the lines were fuzzy and the first pair of diffraction bands conspicuous.

Now the distance between the first pair of minima in the diffraction pattern varies directly as the distance between the *réseau* and the plate and inversely as the width of the *réseau* line, and this suggested that a wider line might give a sharper image. I silvered some glass plates and ruled a number of lines of various widths. Exposures on plates tilted behind these experimental *réseaux* showed that the lines about $0^{mm}\cdot02$ wide gave on the whole the best results. The definition of the image was scarcely impaired with a separation of $0^{mm}\cdot5$, and fell off slowly beyond that.

M. Gautier has, in accordance with this result, made for the Observatory another *réseau*, No. 88, in which the lines were to be $0^{mm}\cdot02$ wide. They are actually very slightly narrower than this. But the new *réseau* is a very great improvement on the old one, and we have been able, without damage to the silver film, to impress good images of it on the commercial plates at present used with our five-inch portrait lens. I believe, then, that it will be found that an increase of the width of the ruling to $0^{mm}\cdot02$ is of great advantage. It should bring nearer the time when every celestial photograph has a *réseau* impressed on it.

Various methods have been employed for impressing the *réseau* upon the plate, but they nearly all agree in the use of parallel light. The most general practice seems to be to put the *réseau* slide over the object-glass and use a small source of light in the focal plane of the telescope. This is troublesome, and it seems to me to be unnecessary, if not actually disadvantageous. I believe that it would be better to use a small source of light placed at a distance from the *réseau* equal to the focal length of the telescope, without any collimator.

We cannot use a source of light which is practically a point source, because the exposure required is inconveniently long. If we use light coming through a diaphragm of, say, $\frac{1}{4}$-inch aperture, the geometrical divergence of a pencil of light passing through the *réseau* is the same in both cases, and in any case the consequent widening in the image is negligible in comparison with the effects of diffraction.

If we use divergent light, the scale value of the image is altered by a small amount depending upon the separation between *réseau* and plate and the distance of the light source. But this is of no importance whatever. The angular value of the *réseau* interval is quite arbitrary, depending in the first place upon the mean focal length of the objective, which may easily differ from

its designed value by several times the separation between *réseau* and plate; and in the second place upon the actual focal length as affected by temperature from day to day.

It appears, then, that we lose nothing by employing light diverging from a source at the focal distance instead of the more or less parallel light from the same source in the focus of a collimator. And in one respect we gain. Suppose the plate is not flat. There will be irregular distortion in the field, since the stars are projected from the centre of the objective. If we put on the *réseau* with parallel light, there is no distortion of its image on the plate; if with light from a source at a distance from the plate equal to the focal length, the distortions of the *réseau* image are approximately the same as the distortions of the neighbouring stars, unless the irregularities in the plate are very abrupt. We have thus a method of avoiding to a large extent the accidental errors due to curvature of the plate.

My conclusions are, then, that it is advisable to increase the width of the ruled *réseau* lines to $0^{mm}\cdot02$, and to impress them on the plate by light from a source placed without any collimator at a distance equal to the focal length of the photographic objective.

Cambridge Observatory:
1899 *June* 6.

On the formulæ of reduction to the meridian of the observed zenith distances of stars. By A. E. Young.

The author being unable to reconcile the formulæ given in the "Handbook of Professional Instructions for the Trigonometrical Branch, Survey of India Department," p. 177, for the correction to the observed zenith distance of a star for instrumental error, with those given by Chauvenet in his "Spherical and Practical Astronomy," 5th ed. vol. ii. pp. 290–291, for the meridian circle, was led to an examination of the latter, from which it appears that the discrepancies were caused in the first place by some small terms having been neglected by Chauvenet in forming the expansion for the correction, and in the second to his having assumed that the correction to what he calls the instrumental declination is the same as the correction to the instrumental zenith distance of the star. At any rate, the latter assumption is made in the example he gives. These assumptions, which involve neglecting terms depending on n only, will hardly affect observations made with the meridian circle, in which n is usually very small; but in the case of a portable altazimuth or zenith telescope they may have an appreciable effect, and it will be inter-